CLAIMS

We claim:

1. A dual spin valve (SV) sensor, comprising:

a first spin valve (SV) stack;

a second spin valve (SV) stack; and

a longitudinal bias stack disposed between said first and second SV stacks.

2. The dual SV sensor as recited in claim 1, wherein said longitudinal bias stack comprises:

a first ferromagnetic (FM1) layer;

a second ferromagnetic (FM2) layer;

an antiferromagnetic layer disposed between said FM1 and FM2 layers;

a first decoupling layer disposed between said first SV stack and said FM1 layer; and

a second decoupling layer disposed between said FM2 layer and said second SV stack.

3. A dual spin valve (SV) sensor, comprising:

a first spin valve (SV) stack, comprising:

a first antiferromagnetic (AFM1) layer;

a first antiparallel (AP)-pinned layer in contact with said AFM1 layer;

a first sense layer of ferromagnetic material;

a first spacer layer disposed between said first sense layer and said first AP-pinned layer;

a second spin valve (SV) stack, comprising:

a second antiferromagnetic (AFM2) layer;

a second antiparallel (AP)-pinned layer in contact with said AFM2 layer;

a second sense layer of ferromagnetic material;

a second spacer layer disposed between said second sense layer and said second AP-pinned layer; and

a longitudinal bias stack disposed between said first and second sense layers, said longitudinal bias stack comprising:

a first ferromagnetic (FM1) layer;

a second ferromagnetic (FM2) layer;

a third antiferromagnetic (AFM3) layer disposed between said FM1 and FM2 layers;

a first decoupling layer disposed between said first sense layer and said FM1 layer; and

a second decoupling layer disposed between said FM2 layer and said second sense layer.

4. The dual SV sensor as recited in claim 3, wherein said AFM1 and AFM2 layers are made of Pt-Mn.

5. The dual SV sensor as recited in claim 3, wherein said AFM3 layer is made of Ir-Mn.

6. The dual SV sensor as recited in claim 3, wherein a first blocking temperature of the AFM1 and AFM2 layers is greater than a second blocking temperature of the AFM3 layer.

7. The dual SV sensor as recited in claim 3, wherein said first decoupling layer comprises:

a first sublayer made of Cu-O adjacent to said first sense layer; and

a second sublayer made of ruthenium disposed between said first sublayer and said FM1 layer.

8. The dual SV sensor as recited in claim 3, wherein said second decoupling layer comprises:

a second sublayer made of Cu-O adjacent to said second sense layer; and

a first sublayer made of ruthenium (Ru) disposed between said second sublayer and said FM2 layer.

9. A dual spin valve (SV) sensor, comprising:

a first spin valve (SV) means for providing a first readback signal in response to a magnetic signal field, said first SV means including a first sense layer means responsive to said magnetic signal field;

a second spin valve (SV) means for providing a second readback signal in response to a magnetic signal field, said second SV means including a second sense layer means responsive to said magnetic signal field; and

a bias means for providing longitudinal bias fields at said first and second sense layer means to stabilize said first and second SV means, said bias means disposed between said first and second sense layer means.

10. A magnetic read/write head, comprising:

a write head including:

at least one coil layer and an insulation stack, the coil layer being embedded in the insulation stack;

first and second pole piece layers connected at a back gap and having pole tips with edges forming a portion of an air bearing surface (ABS);

the insulation stack being sandwiched between the first and second pole piece layers; and

a write gap layer sandwiched between the pole tips of the first and second pole piece layers and forming a portion of the ABS;

a read head including:

a dual spin valve (SV) sensor, the dual SV sensor being sandwiched between first and second shield layers, the dual SV sensor comprising:

a first spin valve (SV) stack;

a second spin valve (SV) stack; and

a longitudinal bias stack disposed between said first and second SV stacks; and

an insulation layer disposed between the second shield layer of the read head and the first pole piece layer of the write head.

11. The magnetic read/write head as recited in claim 10, wherein said longitudinal bias stack comprises:

a first ferromagnetic (FM1) layer;

a second ferromagnetic (FM2) layer;

an antiferromagnetic layer disposed between said FM1 and FM2 layers; and

a first decoupling layer disposed between said first SV stack and said FM1 layer; and

a second decoupling layer disposed between said FM2 layer and said second SV stack.

12. A magnetic read/write head, comprising:

a write head including:

at least one coil layer and an insulation stack, the coil layer being embedded in the insulation stack;

first and second pole piece layers connected at a back gap and having pole tips with edges forming a portion of an air bearing surface (ABS);

the insulation stack being sandwiched between the first and second pole piece layers; and

a write gap layer sandwiched between the pole tips of the first and second pole piece layers and forming a portion of the ABS;

a read head including:

a dual spin valve (SV) sensor, the SV sensor being sandwiched between first and second shield layers, the SV sensor comprising:

a first spin valve (SV) stack, comprising:

a first antiferromagnetic (AFM1) layer;

a first antiparallel (AP)-pinned layer in contact with said AFM1 layer;

a first sense layer of ferromagnetic material;

a first spacer layer disposed between said first sense layer and said first AP-pinned layer;

a second spin valve (SV) stack, comprising:

a second antiferromagnetic (AFM2) layer;

a second antiparallel (AP)-pinned layer in contact with said AFM2 layer;

a second sense layer of ferromagnetic material;

a second spacer layer disposed between said second sense layer and said second AP-pinned layer; and

a longitudinal bias stack disposed between said first and second sense layers, said longitudinal bias stack comprising:

a first ferromagnetic (FM1) layer;

a second ferromagnetic (FM2) layer;

a third antiferromagnetic (AFM3) layer disposed between said FM1 and FM2 layers;

a first decoupling layer disposed between said first sense layer and said FM1 layer; and

a second decoupling layer disposed between said FM2 layer and said second sense layer; and

an insulation layer disposed between the second shield layer of the read head and the first pole piece layer of the write head.

13. The magnetic read/write head as recited in claim 12, wherein said AFM1 and AFM2 layers are made of Pt-Mn.

14. The magnetic read/write head as recited in claim 12, wherein said AFM3 layer is made of Ir-Mn.

15. The magnetic read/write head as recited in claim 12 wherein a first blocking temperature of the AFM1 and AFM2 layers is greater than a second blocking temperature of the AFM3 layer.

16. A magnetic read/write head, comprising:

a write head including:

at least one coil layer and an insulation stack, the coil layer being embedded in the insulation stack;

first and second pole piece layers connected at a back gap and having pole tips with edges forming a portion of an air bearing surface (ABS);

the insulation stack being sandwiched between the first and second pole piece layers; and

a write gap layer sandwiched between the pole tips of the first and second pole piece layers and forming a portion of the ABS;

a read head including:

a dual spin valve (SV) sensor, the SV sensor being sandwiched between first and second shield layers, the SV sensor comprising:

a first spin valve (SV) means for providing a first readback signal in response to a magnetic

signal field, said first SV means including a first sense layer means responsive to said magnetic signal field;

a second spin valve (SV) means for providing a second readback signal in response to a magnetic signal field, said second SV means including a second sense layer means responsive to said magnetic signal field; and

a bias means for providing longitudinal bias fields at said first and second sense layer means to stabilize said first and second SV means, said bias means disposed between said first and second sense layer means; and

an insulation layer disposed between the second shield layer of the read head and the first pole piece layer of the write head.

17. A disk drive system comprising:

a magnetic recording disk;

a magnetic read/write head for magnetically recording data on the magnetic recording disk and for sensing magnetically recorded data on the magnetic recording disk, said magnetic read/write head comprising:

a write head including:

at least one coil layer and an insulation stack, the coil layer being embedded in the insulation stack;

first and second pole piece layers connected at a back gap and having pole tips with edges forming a portion of an air bearing surface (ABS);

the insulation stack being sandwiched between the first and second pole piece layers; and

a write gap layer sandwiched between the pole tips of the first and second pole piece layers and forming a portion of the ABS;

a read head including:

a dual spin valve (SV) sensor, the SV sensor being sandwiched between first and second shield layers, the SV sensor comprising:

a first spin valve (SV) stack;

a second spin valve (SV) stack; and

a longitudinal bias stack disposed between said first and second SV stacks; and

an insulation layer disposed between the second shield layer of the read head and the first pole piece layer of the write head;

an actuator for moving said magnetic read/write head across the magnetic disk so that the read/write head may access different regions of the magnetic recording disk; and

a recording channel coupled electrically to the write head for magnetically recording data on the magnetic recording disk and to the SV sensor of the read head for detecting changes in resistance of the SV sensor in response to magnetic fields from the magnetically recorded data.

18. The disk drive system as recited in claim 17, wherein said longitudinal bias stack comprises:

a first ferromagnetic (FM1) layer;

a second ferromagnetic (FM2) layer;

an antiferromagnetic layer disposed between said FM1 and FM2 layers;

a first decoupling layer disposed between said first SV stack and said FM1 layer; and

a second decoupling layer disposed between said FM2 layer and said second SV stack.

19. A disk drive system comprising:

a magnetic recording disk;

a magnetic read/write head for magnetically recording data on the magnetic recording disk and for sensing magnetically recorded data on the magnetic recording disk, said magnetic read/write head comprising:

a write head including:

at least one coil layer and an insulation stack,

the coil layer being embedded in the insulation stack;

first and second pole piece layers connected at a back gap and having pole tips with edges forming a portion of an air bearing surface (ABS);

the insulation stack being sandwiched between the first and second pole piece layers; and

a write gap layer sandwiched between the pole tips of the first and second pole piece layers and forming a portion of the ABS;

a read head including:

a dual spin valve (SV) sensor, the SV sensor being sandwiched between first and second shield layers, the SV sensor comprising:

a first spin valve (SV) stack, comprising:

a first antiferromagnetic (AFM1) layer;

a first antiparallel (AP)-pinned layer in contact with said AFM1 layer;

a first sense layer of ferromagnetic material;

a first spacer layer disposed between said first sense layer and said first AP-pinned layer;

a second spin valve (SV) stack, comprising:

a second antiferromagnetic (AFM2) layer;

a second antiparallel (AP)-pinned layer in contact with said AFM2 layer;

a second sense layer of ferromagnetic material;

a second spacer layer disposed between said second sense layer and said second AP-pinned layer; and

a longitudinal bias stack disposed between said first and second sense layers, said longitudinal bias stack comprising:

a first ferromagnetic (FM1) layer;

a second ferromagnetic (FM2) layer;

a third antiferromagnetic (AFM3) layer disposed between said FM1 and FM2 layers;

a first decoupling layer disposed between said first sense layer and said FM1 layer; and

a second decoupling layer disposed between said FM2 layer and said second sense layer; and

an insulation layer disposed between the second shield layer of the read head and the first pole piece layer of the write head; and

an actuator for moving said magnetic read/write head across the magnetic disk so that the read/write head may access different regions of the magnetic recording disk; and

a recording channel coupled electrically to the write head for magnetically recording data on the magnetic recording disk and to the SV sensor of the read head for detecting changes in resistance of the SV sensor in response to magnetic fields from the magnetically recorded data.

20. The disk drive system as recited in claim 19, wherein said AFM1 and AFM2 layers are made of Pt-Mn.

21. The disk drive system as recited in claim 19, wherein said AFM3 layer is made of Ir-Mn.

22. The disk drive system as recited in claim 19, wherein a first blocking temperature of the AFM1 and AFM2 layers is greater than a second blocking temperature of the AFM3 layer.

23. A disk drive system comprising:

a magnetic recording disk;

a magnetic read/write head for magnetically recording data on the magnetic recording disk and for sensing magnetically recorded data on the magnetic recording disk, said magnetic read/write head comprising:

a write head including:

at least one coil layer and an insulation stack, the coil layer being embedded in the insulation stack;

first and second pole piece layers connected at a back gap and having pole tips with edges forming a portion of an air bearing surface (ABS);

the insulation stack being sandwiched between the first and second pole piece layers; and

a write gap layer sandwiched between the pole tips of the first and second pole piece layers and forming a portion of the ABS;

a read head including:

a dual spin valve (SV) sensor, the SV sensor being sandwiched between first and second shield layers, the SV sensor comprising:

a first spin valve (SV) means for providing a first readback signal in response to a magnetic signal field, said first SV means including a first sense layer means responsive to said magnetic signal field;

a second spin valve (SV) means for providing a second readback signal in response to a magnetic signal field, said second SV means including a second sense layer means

responsive to said magnetic signal field; and

a bias means for providing longitudinal bias fields at said first and second sense layer means to stabilize said first and second SV means, said bias means disposed between said first and second sense layer means;

an insulation layer disposed between the second shield layer of the read head and the first pole piece layer of the write head; and

an actuator for moving said magnetic read/write head across the magnetic disk so that the read/write head may access different regions of the magnetic recording disk; and

a recording channel coupled electrically to the write head for magnetically recording data on the magnetic recording disk and to the SV sensor of the read head for detecting changes in resistance of the SV sensor in response to magnetic fields from the magnetically recorded data.

24. A method of fabricating a dual spin valve (SV) sensor which comprises the steps of:

a) sputter depositing the multilayer dual SV sensor including a first spin valve (SV) stack, a second spin valve (V) stack and a longitudinal bias stack disposed between the first and second SV stacks;

b) annealing the dual SV sensor at a first temperature in a first magnetic field oriented in a transverse direction perpendicular to an air bearing surface; and

c) annealing the dual SV sensor at a second temperature in a second magnetic field oriented in a longitudinal direction parallel to said air bearing surface, wherein said second temperature is less than said first temperature and said second magnetic field has a magnitude smaller than said first magnetic field.

25. The method of fabricating a dual SV sensor as recited in claim 24, wherein said first temperature is about 280° C and said second temperature is about 240° C.

26. The method of fabricating a dual SV sensor as recited in claim 24, wherein said first first magnetic field has a magnitude of about 10,000 Oe and said second magnetic field has a magnitude of about 200 Oe.

27. A dual hybrid spin valve (SV)/magnetic tunnel junction (MTJ) sensor, comprising:

a spin valve (SV) stack;

a magnetic tunnel junction (MTJ) stack; and

a longitudinal bias stack disposed between said SV and MTJ stacks.

28. The dual hybrid SV/MTJ sensor as recited in claim 27, wherein said longitudinal bias stack comprises:

a first ferromagnetic (FM1) layer;

a second ferromagnetic (FM2) layer;

an antiferromagnetic layer disposed between said FM1 and FM2 layers;

a first decoupling layer disposed between said SV stack and said FM1 layer; and

a second decoupling layer disposed between said FM2 layer and said MTJ stack.

29. A dual hybrid spin valve (SV)/magnetic tunnel junction (MTJ) sensor, comprising:

a spin valve (SV) stack, comprising:

a first antiferromagnetic (AFM1) layer;

a first antiparallel (AP)-pinned layer in contact with said AFM1 layer;

a first sense layer of ferromagnetic material;

a first spacer layer disposed between said first sense layer and said first AP-pinned layer;

a magnetic tunnel junction (MTJ) stack, comprising:

a second antiferromagnetic (AFM2) layer;

a second antiparallel (AP)-pinned layer in contact with said AFM2 layer;

a second sense layer of ferromagnetic material;

a tunnel barrier layer disposed between said second sense layer and said second AP-pinned layer; and

a longitudinal bias stack disposed between said first and second sense layers, said longitudinal bias stack comprising:

a first ferromagnetic (FM1) layer;

a second ferromagnetic (FM2) layer;

a third antiferromagnetic (AFM3) layer disposed between said FM1 and FM2 layers;

a first decoupling layer disposed between said first sense layer and said FM1 layer; and

a second decoupling layer disposed between said FM2 layer and said second sense layer.

30. The dual hybrid SV/MTJ sensor as recited in claim 29, wherein said AFM1 and AFM2 layers are made of Pt-Mn.

31. The dual hybrid SV/MTJ sensor as recited in claim 29, wherein said AFM3 layer is made of Ir-Mn.

32. The dual hybrid SV/MTJ sensor as recited in claim 29, wherein a first blocking temperature of the AFM1 and AFM2 layers is greater than a second blocking temperature of the AFM3 layer.

33. The dual hybrid SV/MTJ sensor as recited in claim 29, wherein said first decoupling layer comprises:

a first sublayer made of Cu-O adjacent to said first sense layer; and

a second sublayer made of ruthenium (Ru) disposed between said first sublayer and said FM1 layer.

34. The dual hybrid SV/MTJ sensor as recited in claim 29, wherein said second decoupling layer comprises:

a second sublayer made of Cu-O adjacent to said second sense layer; and

a first sublayer made of ruthenium (Ru) disposed between said second sublayer and said FM2 layer.

35. A dual hybrid spin valve (SV)/magnetic tunnel junction (MTJ) sensor, comprising:

a spin valve (SV) means for providing a first readback signal in response to a magnetic signal field, said SV means including a first sense layer means responsive to said magnetic signal field;

a magnetic tunnel junction (MTJ) means for providing a second readback signal in response to a magnetic signal field, said MTJ means including a second sense layer means responsive to said magnetic signal field; and

a bias means for providing longitudinal bias fields at said first and second sense layer means to stabilize said SV and MTJ means, said bias means disposed between said first and second sense layer means.